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CLASS: FE/ ELEC SEM: I

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TITLE: Laser and fiber optics.

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MARKS: _____

FACULTY MEMBER (WITH DATE)



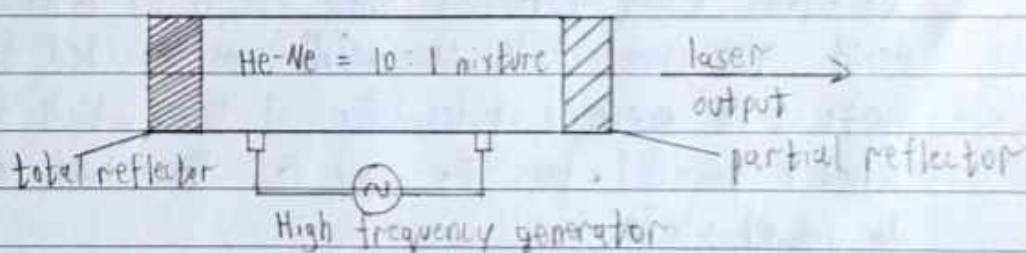
He-Ne Laser :

construction :

i) Active medium: This is the mixture of ~~He-Ne~~ Helium and Neon gases with the ratio 10 : 1, filled in pyrex tube of diameter at about 1.5 cm and length of about 35 cm. The pressure of inside the tube is maintained at about 1 mm of Hg. Here 'He' is the host gas and 'Ne' is an activator because Ne takes part actively in lasing transition.

ii) Energy source: This is a high voltage power source of about 4 kV DC connected to pyrex tube to excite the active medium. Hence, the pumping is electrical pumping.

iii) Resonant/optical cavity: A pair of reflectors, one total and one partial filled to two inner end surfaces of the pyrex tube.



Construction of He-Ne laser

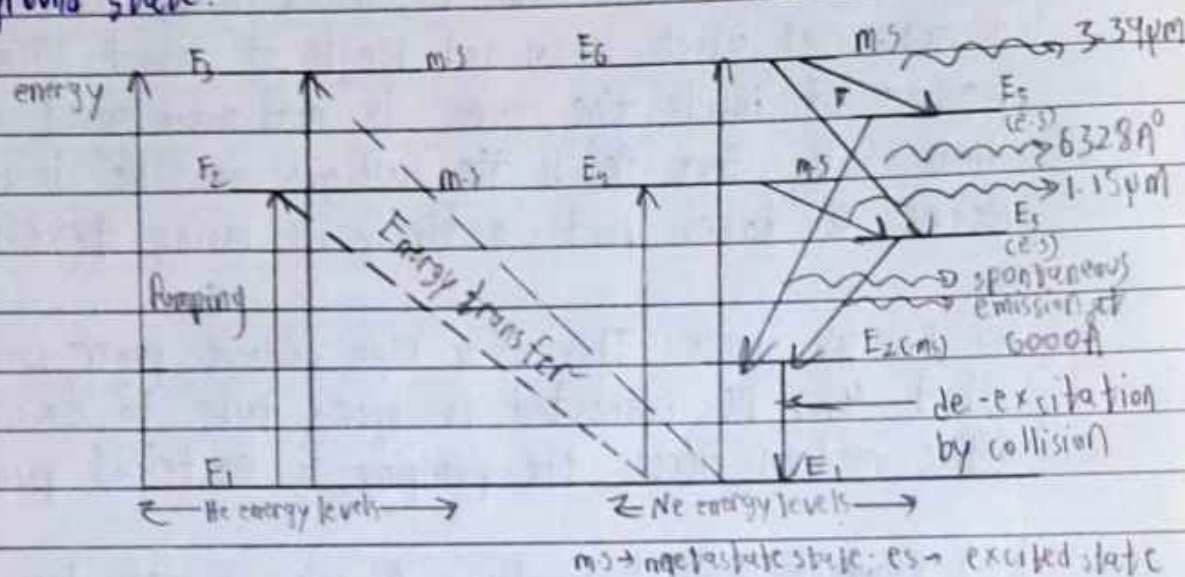
Working:

i) As the high power voltage is switched on, the high energy electrons start flowing through the gas mixture and collide with He and Ne atoms. At the time of impact, the electrons transfer their kinetic energy to gas atoms. He atoms being fairly lighter than Ne atoms, absorb the kinetic energy and are



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excited to the ~~metastable~~ metastable levels E_2 and E_3 easily from ground state E_1 . This is the pumping transition of He atoms. During this transition, Ne atoms exist in ground state.



2) Two gases are in close energy level structures shown in the diagram. The excited He atoms collide with ground state Ne atoms and transfer their energy to later. As a result, the ground state Ne ~~atoms~~ ^{atoms} are excited to metastable energy states E_4 and E_3 , which are almost parallel to E_3 and E_2 . He atoms return to ground state.

3) This causes population inversion in Ne at E_4 and E_3 levels with respect to E_5 and E_2 levels and lasing occurs on three possible transitions:

- $E_5 \rightarrow E_4$ emitting LASER of wavelength 339 μm in infrared region.
- $E_4 \rightarrow E_3$ emitting LASER of wavelength 6328 Å in visible region
- and $E_3 \rightarrow E_2$ emitting LASER of wavelength 1.15 μm in infrared region.



4) The levels E_5 and E_3 are excited states where the life time of Ne atoms is about 10^{-8} sec. Hence, the Ne atoms transit to the metastable state E_2 and E_5 and E_3 levels by spontaneous emission.

level

5) The ~~energy state~~ E_2 is metastable from which spontaneous emission is rare. Hence, Ne atoms are accumulated at level E_2 . During their stay at E_2 level Ne atoms collide with the tube walls and give up their excess energy as heat energy and returns to ground state.

6) By the time the first set of Ne atoms return to ground state one more ~~set~~ set of Ne atoms are raised to level E_4 and E_6 inducing population inversion and resulting in Lasing action. Hence, He-Ne laser operates continuously and hence emits continuous wave.

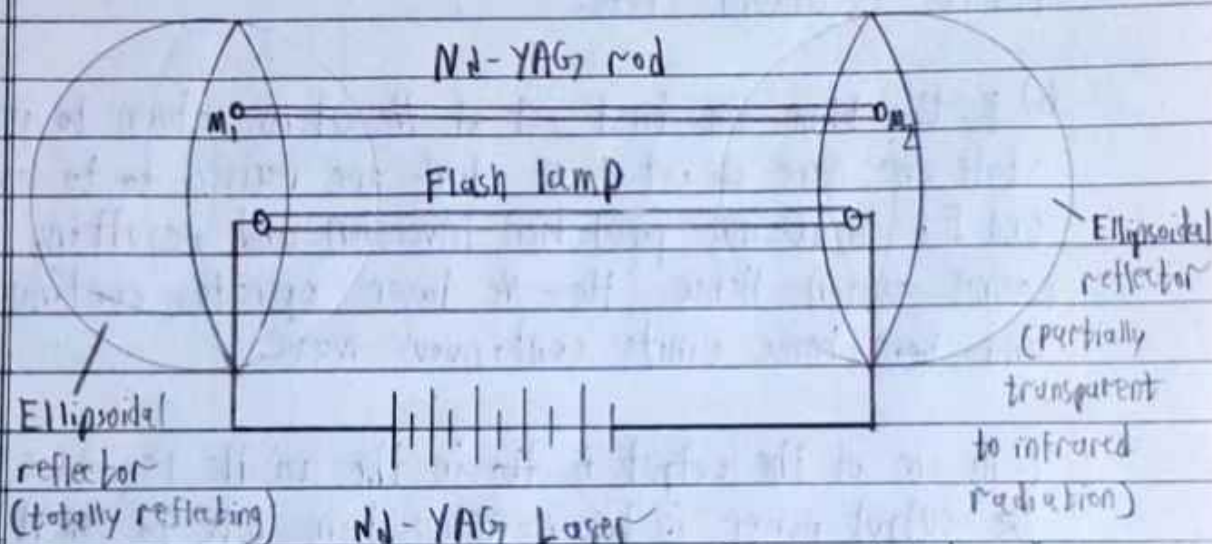
7) As one of the output is in the visible region (6328 \AA) the output power is low ranging from 1 mW to 50 mW . Though the output power is low, due to coherent radiation the intensity of the output radiation is very high. So it is dangerous to look at the source directly.



Nd-YAG Laser:

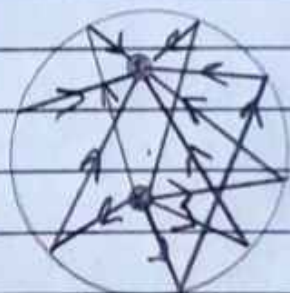
Construction:

The system consists of a pair of optically cylindrical reflectors housing the Nd-YAG rod along one focus line and the flash lamp along the other focus line. The light leaving one focus of the ellipse reaches the other focus after reflection from the inner silvered surface of the cylindrical reflectors. Thus the total flash lamp radiation is incident on the Nd-YAG rod.



M_1 : totally polished surface

M_2 : partially polished surface

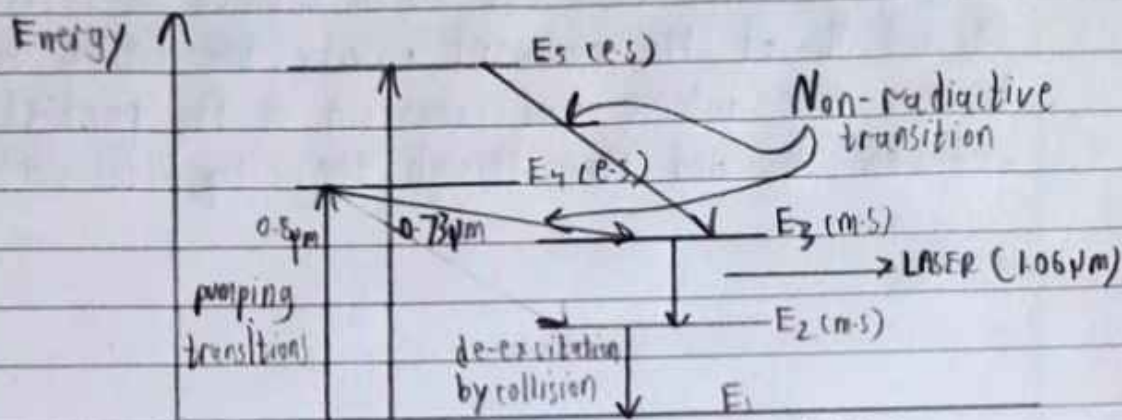


Crosssectional view of the reflections in cylindrical reflector



Working :

1) The working of the Nd-YAG LASER is explained with the help of the energy level diagram as shown in diagram:



Energy level diagram of Nd-YAG Laser

2) When krypton flash lamp is switched on it emits intense radiation of wavelength range 7000 \AA to 8000 \AA

3) The Nd^{3+} atoms absorb this energy and are pumped to the excited states E_4 and E_5 .

4) Being unstable at levels E_4 and E_5 , Nd^{3+} atoms make a non radiative transition to the metastable state E_3 .

5) The state of population inversion is developed between levels E_3 and E_2 .

6) Few Nd^{3+} ions make fast transition from level E_3 to E_2 emitting spontaneous photons. These photons initiate the stimulated emission of the rest of the Nd^{3+} atoms.



- 7) Lasing transition takes place from E_3 to E_2 level emitting LASER of wavelength 10600 \AA in infrared region.
- 8) Being reflected back and forth between the reflectors, M_1 and M_2 of the resonant cavity, the LASER beam becomes more intense and comes out of the partial reflector M_2 and then through the ellipsoidal surface.